Renewable energy growth niamey

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In an attempt to realize the most beneficial and optimal mix of electricity generation in Niger, a society"s cost of electricity (SCOE) as the levelized cost of electricity (LCOE) plus the cost of climate change and air pollution is formulated. The SCOE is used as a basis for setting the performance criteria for supply optimization to balance future electricity demand in Niger. The demand projection is derived from a system dynamics model that anticipates future changes based on its influencing factors of population growth, urbanization progress, and industrial development.

In this work, a mixed energy grid is optimized primarily on affordability while considering its sustainability. The implemented holistic approach lessens the need for energy import in the country and provides relief to energy security issues such as electricity price volatility and supply reliability. Additionally, the proposed strategy helps to guide the renewable energy transition pathway in Niger.

Per capita electricity consumption of Niger in comparison with selected West African countries in 2017

The relationship between economic development and increased energy demand [3, 6,7,8] as well as the strong correlation between urbanization and enhanced energy utilization [3, 6, 8,9,10,11] are clearly observed in the literature. These trends are also accompanied with a relative political stability and large-scale investments in the mining and oil sector of a country, which is also evident in Niger. Often, economic development reciprocates into increased energy consumption by the industrial and urban sectors. Thus, the development of a valid model that translates and anticipates quantitatively these related events would help energy policymakers to realize the development goals.

Electricity import to Niger (based on NIGELEC database) [13]

Finally, the absence of an energy mix in the power grid based on the availability and cost of generation (including the cost on the environment), which has led to an inefficient fossil dominated power generation, is another challenge to the provision of low-cost and reliable energy in Niger. Apart from an estimated 2% solar photovoltaic (PV) installation in the telecom and off-grid sectors, power generation in the country still relies entirely on fossil fuels (coal and diesel) [12, 13]. Moreover, many of NIGELEC"s diesel power plants are close to the decommissioning phase but continue to operate with high generation costs [13].

Against this backdrop, solar PV and hydropower hold the promise of becoming suitable alternative energy sources in Niger. An attractive medium to large hydropower potential in the country is estimated at about 312-450 MW [17, 18]. Until now, only a feasible potential assessment has been carried out for a few sites, such as Dyodyonga, Gambou, and Kandadji, with an estimated hydroelectric power potential of about 38, 122.5, and 125 MW, respectively [17]. Figure 3 depicts the flow rate of the Niger River in dry and wet seasons measured in Niamey [16]. Some suitable mini-hydropower sites have also been identified along four tributaries of the Niger River, namely Mekrou, Tapoa, Gorouol, and Sirba, amounting to a combined capacity of 3-8 MW [17, 18].

Niger is also endowed with a high solar PV potential. As shown in Fig. 4, almost all regions in the country have a daily average PV potential of over 4.6 kWh/kWp [19]. Thus, if properly designed and operated, power from grid-tied PV systems could provide an efficient method of harvesting the available solar power.

Photovoltaic electricity potential of Niger [19]

A potential assessment that has been carried out in Niger so far indicates that wind resource is negligible [18]. It also showed that conventional sources of energy such as diesel and coal are abundant in the country [20]. Considering these findings and the aforementioned energy-related issues, a holistic approach for finding an optimal energy mix based on the availability and cost of generation (including the cost to the environment) would be necessary and insightful. Moreover, this approach should balance the future energy demand and include a strategy to lessen the need for imported energy. Therefore, the optimal energy mix criteria should be based on the following trade-offs:

The complementary nature of solar and hydropower should be used to compensate for the lower energy output from hydropower during the dry season.

The high electricity generation cost from solar PV, which has not yet reached a level to be competitive with hydropower, and abundant conventional power sources should be balanced.